THE ARCHÆOLOGY OF SOUTHERN CALIFORNIA [1]

A VALUABLE contribution to American anthropology has recently appeared, published under the auspices of the U.S. Government, forming the seventh volume of the "Reports of the U.S. Geographical Surveys West of the One Hundredth Meridian." It deals mainly with the remains of the Indians of Southern California, their implements, weapons, vessels, and ornaments.

The observers and collectors were those engaged upon the work of the survey, some of them detailed for work of a different character, but fortunately able to render valuable assistance in explorations for archæological finds.

The letterpress embodies the work of F. W. Putnam, the distinguished curator of the Peabody Museum, whose editorial revision and direction has moulded the whole, that of A. A. Abbott, the veteran explorer of the antiquities of New Jersey, H. C. Yarrow, S. S. Haldeman, A. S. Gatschet, H. W. Henshaw, and Lucien Carr, whose report upon the measurements of the crania from California is most suggestive and important. Besides their own contributions to the principal subject, these gentlemen have freely used the short descriptions of the personal visits of the officers of the army and others to the Pueblo villages of New Mexico and Arizona.

The present inhabitants of Central and Southern California are regarded as a degenerate race deteriorated from an ancestral people of superior parts, and they afford to-day a marked contrast with the more advanced and intelligent races of Northern California. This inferiority has been recognised by all observers, and was comprehended by the Jesuit missionaries, whose unfortunate system, however much its zealous propagation recommended their vigour and sincerity, only helped the natural tendency and hastened the course of a degradation already under way.

As early as 1534 the Spanish explorers invaded this region, and met in many instances a warlike and determined resistance. The priest and missal followed the sword and helmet, and completed the destruction of the people by processes more insidious than those of the warrior, but scarcely less fatal. Missions were established, the natives proselytised, not always by moral suasion, and brought under the control of the missions; they existed in a state of appanage, and became listless and degraded.

The natives of the immediate southern border of California show an improvement over those of Central California, approximating to the superior type in Northern California, a contrast which has so impressed the minds of students as to have started the assumption that the Central Californians belong to a different race, and are to be referred to Malay and Chinese origins. It is however with the description of the implements, utensils, ornaments, &c., of the southern Indians as exhumed from burial mounds, and the story told by such mortuary relics of the habits of their ancestors, that this volume is filled.

Attention had been directed by the Smithsonian Institution to the area upon the coast of California opposite the group of Santa Barbara Islands, and to these islands themselves, as a promising field for archæological search. The indications followed rewarded the Survey with many important objects, enough to permit a conception of the life of their makers.

These latter were in the stone age depending upon stone and bone implements as tools of war, chase, and industry. They seem to have been almost entirely without a knowledge of pottery, but this need may have been scarcely felt from their skill in the manufacture of stone vessels formed from steatite masses, and of all sizes, and adapted to the commonest domestic uses.

This series of objects affords a striking example of their patience and ingenuity. They are described under the designation of "Cooking pots and food vessels." They are in the main oblate spheroidal vessels of soapstone thickened over the base and sides exposed to the heat, and thinning towards the rim of the circular opening upon the top. The smaller specimens are frequently much finished in their smoothness, and vary enough in size and shape to suggest that they were the property of individuals, and prepared and kept for the personal use of their owners. These small vessels often show mending where fractured, a row of holes being perforated upon the two opposite sides of a crack, and the edges drawn together by sinews which are sunk in grooves, over which has been plastered asphaltum. Asphaltum figures in various ways, and was constantly resorted to as a convenient cement; it was employed to fasten their stone-bolts and arrow-heads to their shafts, to attach mouth-pieces to their pipes, the line to their fish-hooks, &c., it formed a surface over their objects upon which ornaments could be imbedded in rude decoration, and figures on their shell beads in spiral lines of black.

Besides the *ollas*, various dish-like utensils are figured with one or more holes for suspension after use, or for removal from the fire, being probably used as baking pans. Stone mortars of basalt and sandstone, small colour mixers, dishes of shell (*Haliotis*), and cups formed of fish vertebræ complete the list of serviceable vessels.

The smoking-pipes, which are carefully studied and described by Dr. Abbott, are long, straight, conical, and sub-cylindrical tubes of steatite, displaying no great variety of form and but inconspicuous attempts at ornamentation. The straight tube corresponding to the bowl of the common pipe is in line with the opening at the insertion of the mouthpiece, and it would seem that tubes of bone or reed inserted for stems must have been curved to permit of their use in any normal position.

The chipped flints are of striking beauty, and will be recognised by all who have examined specimens of ornamental spears and daggers from this region. They are shown of natural size upon two plates of considerable beauty, and vary from 4 inches to 8 or 10 inches in length, lenticular in section, and present ripple-like and corrugated surfaces of very delicate sculpture. The chapters upon perforated stones, miscellaneous objects made of stone, and textile fabrics are especially interesting.

The claim of any great age for these relics seems precluded by their association with glass beads, bronze cups and platters, iron swords, nails, knives, and pistol barrels, all pointing unmistakably to contact with the Spaniards. Yet there can be but little doubt that they perfectly represent the arts of life prevailing among the ancestors of their owners and makers for ages before the appearance of the white man, and that many are themselves heirlooms descended from a great antiquity.

The concluding chapter of Part I. is a suggestive summary of the results of cranial measurements, and the writer, Lucien Carr, indicates the past presence of two races whose intermingling remains are now found upon the Santa Barbara Islands, one—the dolichocephals or long heads—presenting a picture of subjugation and decadence; the other—the brachycephals or short heads—spread over the mainland, occupying the northern islands, and pressing upon the precarious remnant of their predecessors on the southern islands.

Part II. is a diversified compilation of a number of personal narratives of visits to the Pueblo villages, some chapters upon the implements and pottery of their occupants, which seem of a degraded type compared with the productions of their probable ancestors, and a short

[1] "Report upon the U.S. Geographical Surveys West of the One Hundredth Meridian in charge of First Lieutenant Geo. M. Wheeler." Vol. vii. "Archæology." (Washington, 1879.)

review of cranial measurements. The material seems insufficient and fragmentary, and affords imperfect means for judging in a satisfactory way of the exact status and organisation of these people. A final contribution to the linguistics of the subject, by A. S. Gatschet, closes the volume, with a compendious statement of the relations of the tribes of the western coast with a list of forty vocabularies of western languages.

Finally, this handsome volume, in typography, paper, and illustrations, is of irreproachable beauty, and it treats of a field in archæological study of deep interest and wide import. L. P. GRATACAP

THE SIZE OF ATOMS[1]

II.

IN making brass, if we mix zinc and copper together we find no very manifest signs of chemical affinity at all; there is not a great deal of heat developed: the mixture does not become warm, *it does not explode*. Hence we can infer certainly that contact-electricity action ceases, or does not go on increasing according to the same law, when the metals are subdivided to something like 1/100,000,000 of a centimetre. Now this is an exceedingly important argument. I have more decided data as to the actual magnitude of atoms or molecules to bring before you presently, but I have nothing more decided in *giving for certain a limit to supposable smallness*. We cannot reduce zinc and copper beyond a certain thickness without putting them into a condition in which they lose their properties as wholes, and in which, if put together, we should *not* find the same attraction as we should calculate upon from the thicker plates. I think it is impossible consistently with the knowledge we have of chemical affinities and of the effect of melting zinc and copper together, to admit that a piece of copper or zinc could be divided to a thinness of much less, if at all less, than 1/100,000,000 of a centimetre without separating the atoms or dividing the molecules, or doing away with the composition which constitutes as a whole the solid metal. In short, the structure as it were of bricks, or molecules, or atoms, of which copper and zinc are built up; cannot be much, if at all, less than 1/100,000,000 of a centimetre in diameter, and may be considerably greater.

I will now read you a statement from an article which was published thirteen years ago in NATURE.[2]

"Now let a second plate of zinc be brought by a similar "process to the other side of the plate of copper; a second "plate of copper to the remote side of this second plate of "zinc, and so on till a pile is formed consisting of 50,001 "plates of zinc and 50,000 plates of copper, separated by "100,000 spaces, each plate and each space 1/100,000 of "a centimetre thick. The whole work done by electric "attraction in the formation of this pile is two centimetre-"grammes.

"The whole mass of metal is eight grammes. Hence "the amount of work is a quarter of a centimetre-gramme "per gramme of metal. Now 4030 centimetre-grammes of "work, according to Joule's dynamical equivalent of heat, "is the amount required to warm a gramme of zinc or "copper by one degree Centigrade. Hence the work done "by the electric attraction could warm the substance by "only 1/16,120 of a degree. But now let the thickness of "each piece of metal and of each intervening space be "1/100,000,000 of a centimetre instead of 1/100,000. "The work would be increased a millionfold unless "1/100,000,000 of a centimetre approaches the small-"ness of a molecule. The heat equivalent would therefore "be enough to raise the temperature of the material by "62°. This is barely, if at all, inadmissible, according to "our present knowledge, or, rather, want of knowledge, "regarding the heat of combination of zinc and copper. "But suppose the metal plates and intervening spaces to "be made yet four times thinner, that is to say, the thick-"ness of each to be 1/400,000,000 of a centimetre. The "work and its heat equivalent will be increased sixteen-"fold. It would therefore be 990 times as much as that "required to warm the mass by 1° C., which is very much "more than can possibly be produced by zinc and copper "in entering into molecular combination. Were there in "reality anything like so much heat of combination as this, "a mixture of zinc and copper powders would, if melted in "any one spot, run together, generating more than heat "enough to melt each throughout; just as a large quantity "of gunpowder if ignited in any one spot burns throughout "without fresh application of heat. Hence plates of zinc "and copper of 1/300,000,000 of a centimetre thick, "placed close together alternately, form a near approxima-"tion to a chemical combination, if indeed such thin plates "could be made without splitting atoms."

Similar conclusions result from that curious and most interesting phenomenon, the soap-bubble. Philosophers old and young who occupy themselves with soap-bubbles, have one of the most interesting subjects of physical science to admire. Blow a soap-bubble and look at it,—you may study all your life perhaps and still learn lessons in physical science from it. You will now see on the screen the image of a soap-film in a ring of metal. The light is reflected from the film filling that ring, and focused on the screen. It will show, as you see, colours analogous to those of Newton's rings. As you see the image it is upside down. The liquid streams down (up in the image) and thins away from the highest point of the film. First we see that brilliant green colour. It will become thinner and thinner there, and will pass through beautiful gradations of colour till you see, as now, a deep red, then much lighter, till it becomes a dusky, yellowish white, then green, and blue, and deep violet, and lastly black, but after you see the black spot it very soon bursts. The film itself seems to begin to lose its tension, when it gets considerably less than a quarter of the wave-length of yellow light, which is the thickness for the dusky white, preceding the final black. When you are washing your hands, you may make and deliberately observe a film like this, in a ring formed by the forefingers and thumbs of two hands, and watch the colours. Whenever you begin to see a black spot or several black spots, the film soon after breaks. The film retains its strength until we come to the black spot, where the thickness is clearly much less than 1/60,000 of a centimetre, which is the thickness of the dusky white.

Newton, in the following passage in his "Optics" (pp. 187 and 191 of edition 1721, Second Book, Part I.), tells more of this important phenomenon of the black spot, than is known to many of the best of modern observers.

"Obs. 17.—If a bubble be blown with water, first made "tenacious by dissolving a little soap in it, it is a common "observation that after a while it will appear tinged with a "variety of colours. To defend these bubbles from being "agitated by the external air (whereby their colours are "irregularly moved one among another so that no accurate "observation can be made of them), as soon as I had "blown any of them I covered it with a clear glass, and by "that means its colours emerged in a very regular order, "like so many concentric rings encompassing the top of "the bubble. And as the bubble grew thinner by the con-"tinual subsiding of the water, these rings dilated slowly "and overspread the whole bubble, descending in order to "the bottom of it, where they vanished successively. In "the meanwhile, after all the colours were emerged at the "top, there grew in the centre of the rings a small round "black spot like that in the first observation, which con-"tinually dilated itself, till it became sometimes more than

[1] A lecture delivered by Sir William Thomson at the Royal Institution, on Friday, February 2. Revised by the Author. Continued from p. 205.

[2] See article "On the Size of Atoms," published in NATURE, vol. i. p. 551; printed in Thomson and Tait's "Natural Philosophy," second edition, 1883, vol. i. part 2, Appendix F.